DSA IR N-4

MODULAR BATTERY ENERGY STORAGE SYSTEMS: 2022 CBC AND CFC

Disciplines: Structural, Fire and Life Safety **History:** Issued 02/15/23 Under 2022 CBC

Division of the State Architect (DSA) documents referenced within this publication are available on the DSA Forms or DSA Publications webpages.

PURPOSE

This Interpretation of Regulations (IR) clarifies specific code requirements relating to battery energy storage systems (BESS) consisting of prefabricated modular structures not on or inside a building for structural safety and fire life safety reviews.

SCOPE

This IR clarifies Structural and Fire and Life Safety design requirements as well as what shall be included in the construction documents.

This IR provides clarification on the design or alternative shake table testing requirements of premanufactured modules and the internal components for seismic loading. The design of BESS modules connections shall comply with the applicable sections of the California Building Code (CBC), American Institute of Steel Construction Specification for Structural Steel Buildings (AISC 360), American Institute of Steel Construction Seismic Provisions for Structural Steel Buildings (AISC 341), and American Society of Civil Engineers Standard 7: Minimum Design Loads and Associated Criteria for Buildings and Other Structures (ASCE 7).

The following regulations address Fire and Life Safety requirements: California Fire Code (CFC), Section 1207, Electrical Energy Storage Systems; California Electrical Code (CEC), Article 706, Energy Storage Systems; and National Fire Protection Association: Standard on Stored Electrical Energy Emergency and Stand-by Power Systems (NFPA-111).

BACKGROUND

Battery energy storage systems (BESS) are devices that enable energy from renewables, like solar and wind, to be stored and then released when customers need powers most. Chapter 12 of the CFC was added to address the current energy systems found in this code and is provided for introducing a wide variety of systems to generate and store energy in, on and adjacent to buildings. The expansion of these energy systems is related to meeting the increasing energy, environmental and economic challenges. Ensuring appropriate criteria to address the safety of such systems in building and fire codes is critical to protecting the public, building occupants and emergency responders.

Cargo containers and prefabricated modular structures are a common method to house the BESS. *IR A-27: Cargo Containers Used as Storage* describes the requirements for the use of cargo containers used as storage and is not applicable to BESS. *IR 16-10: Cargo Container Conversion to Modular Schools Buildings* describes the requirements on the use of cargo containers as school buildings and is applicable to BESS. The exceptions contained in CBC Section 3115 which exempt certain uses of intermodal shipping containers, such as BESS, from complying with the requirements in that section are not adopted by DSA.

MODULAR BATTERY ENERGY STORAGE SYSTEMS: 2022 CBC AND CFC

1. BESS STRUCTURAL DESIGN

1.1 Construction Documents

1.1.1 Per ASCE 7 Section 13.1.5, BESS require complete design that includes construction documents that include the following:

1.1.1.1 Provide a narrative description of the structural design of the BESS enclosure, gravity and lateral loads, including the seismic and wind coefficients, and soil parameters. Refer to CBC Section 1603A for additional requirements.

1.1.1.2 Define all the structural material properties, listing ASTM numbers and grade of each.

1.1.1.3 Provide dimensioned foundation, floor and roof framing plans, including locations of all structural elements (e.g., foundations, walls, beams, columns, joists, diaphragms, etc.).

1.1.1.4 Provide details for all elements of the lateral force resisting system including diaphragms and chords.

1.1.1.5 Dimension and detail all openings in the BESS enclosure.

1.1.1.6 Locate all equipment on the plans, sections and elevations with unit weights noted on the plans.

1.1.1.7 Provide details for all the equipment and component attachments within the BESS as well as external equipment connected to the BESS. Provide complete details, schedules, and notes as required for the entire modular structure, as well as the anchorage and bracing of equipment and components.

1.2 Structural Calculations

1.2.1 Provide structural calculations as follows:

1.2.1.1 The Risk Category shall be IV for the BESS structure and the internal components plus equipment due to the quantity of hazardous (toxic and flammable) materials. The seismic importance factor (I_e and I_p) shall be 1.5.

1.2.1.2 Per ASCE 7 Section 13.1.5, the lateral system for a BESS structure shall be designed per ASCE 7 Chapter 15 with seismic coefficients from Table 15.4-1 for non-building structures similar to buildings. If the BESS utilizes a cargo (shipping) container, the container shall be designed in accordance with IR 16-10.

1.2.1.3 Provide equipment anchorage calculations and cutsheets for all the equipment inside and outside the BESS as well as cutsheets of the BESS showing the location for all the equipment in accordance with ASCE 7 Chapter 13.

1.3 Seismic Shake Table Testing Alternative

Shake table testing per ASCE 7 Section 13.2.5 is an alternative to the structural calculations of the BESS structure as follows:

1.3.1 Shake table testing is an alternative for demonstrating compliance with seismic design of the BESS structure housing the battery racks and other equipment and anchorage of the racks and equipment within the structure. This option complies with ASCE 7 Section 13.1.5 that permits testing to prequalify this system in lieu of designing the structure and anchorage of the racks in accordance with ASCE 7 Chapter 15 and 13, respectively. Shake table testing does not relieve any in-plant welding or in-plant inspector inspections required per Section 1.4 and CBC Chapter 17A. If a shipping container is used as the BESS structure, the shake table testing will be deemed to satisfy Section 3.1 (Lateral Force Resisting System) of IR 16-10 while all other sections of the IR are required to be complied with.

1.3.1.1 For the shake table test alternative, anchorage to the foundation and foundation design shall be designed to the following seismic coefficients from ASCE 7 Chapter 13: Table 13.6-1 (Seismic Coefficients for Mechanical and Electrical Components) "Other Mechanical or Electrical Components" with $a_p = 1.0$, $R_p = 1.5$ and $\Omega_0 = 2.0$. However, if structural analysis can demonstrate the period of the BESS structure is less than 0.06 seconds and can be considered rigid per ASCE 7 Section 11.2 definitions, then seismic coefficients for batteries and inverters may be used ($a_p = 1.0$, $R_p = 2.5$ and $\Omega_0 = 2.0$). The anchorage of the BESS to the site foundation shall be consistent with the boundary conditions used during the shake table testing.
1.3.1.2 The shake table testing shall be conducted in accordance with ICC-ES AC-156 or another acceptable nationally recognized testing standard procedure as referenced in ASCE 7 Section 13.2.5. The testing shall be reviewed by DSA for each project and may require a peer review. Alternatively, the testing is permitted to be submitted to OSHPD/HCAI through their Special Seismic Certification Preapproval (OSP) process which is acceptable to DSA per *IR A-5: Acceptance of Products, Materials & Evaluation Reports*. The HCAI OSP program is detailed in HCAI's Policy Intent Notice (PIN) Special Seismic Certification Preapproval Program (OSP). Furthermore, CBC Section 1705A.14.3 (Special Seismic Certification) provides guidance on number of tests required (2 minimum). DSA will require the importance factor I_e and I_p to be 1.5 for these systems as indicated above.

1.3.1.3 Where it is desired to shake table test a site-specific unit and then ship that same unit to a project site, the comments above are fully applicable. However, there is no requirement to provide in-plant welding or in-plant inspector inspections per Section 1.4 and CBC Chapter 17A, no compliance with IR 16-10, and no need for multiple tests. This method of acceptance is equivalent to CBC Section 1708A (In-Situ Load Tests). However, this approach will require that a structural engineer licensed in California shall visually examine the unit before moving it to a project site to confirm that the unit and contents show no evidence of yielding, failure, damage, or excessive permanent deformations. A detailed report shall be submitted to document the condition of the BESS structure and interior components after testing in accordance with the testing standard.

1.4 Testing and Inspection

1.4.1 Testing and Inspection shall be in accordance with CBC Chapter 17A and California Administrative Code (CAC), which includes but is not limited to in-plant welding and inspector inspections. A DSA Testing and Inspection form *DSA 103: List of Required Structural Tests and Special Inspections* shall be submitted for the project that incorporates testing for the BESS, foundation, and any other project features.

1.4.2 If a BESS structure has already been fabricated prior to in-plant inspection, submit a material test and inspection program for review prior to the pre-application meeting per Section 3.1. Identification of structural steel shall be in accordance with CBC Section 2202A.1.

1.5 Structural Exceptions

1.5.1 The structural plan submittal requirements for the BESS are permitted to be limited to anchorage and foundation (i.e., structural plans and details for the BESS Cabinet are *not* required) where all of the following conditions are met:

1.5.1.1 Individual and grouped BESS units do not exceed a total capacity of 600 kilowatt hours (kwh) and meet the fire separation requirements per CFC 1207.8.3. These separation requirements shall be provided between BESS such that no individual or grouped BESS exceeds 600 kwh.
1.5.1.2 The BESS is housed in an Energy Storage System Cabinet (as defined in CFC Chapter 2) and is not a walk-in structure nor a cargo container.

1.5.2 The structural requirements for BESS meeting the conditions of Section 1.5.1 are as follows:

1.5.2.1 The structural construction documents shall meet Sections 1.1.1.1, 1.1.1.3 (foundation and anchorage only) and 1.1.1.6 above. The remainder of the requirements in Section 1.1 above need not be provided for the BESS Cabinet.

1.5.2.2 The structural design of the foundation and anchorage shall use an importance factor of $I_p = 1.5$ per Section 1.2.1.1 and the seismic anchorage shall utilize seismic coefficients per Section 1.3.1.1.

1.5.2.3 System cabinets not structurally interconnected to adjacent battery cabinets shall be seismically separated by a minimum distance per ASCE 7 Equation 12.12-2 assuming 2.5% of the height the cabinets.

1.5.2.4 The tests and inspections per CBC Chapter 17A and the CAC are limited to the foundation and anchorage of the unit. DSA structural inspections of the construction BESS cabinet are not required.

2. BESS FIRE AND LIFE SAFETY REQUIREMENTS

2.1 General

2.1.1 The California Fire Code requirements depend on the type of the battery system chemistry and their quantity.

2.1.2 Identify the type of the battery system chemistry per the system.

2.1.3 Indicate if the outdoor installation is remote or near exposure in accordance with CFC 1207.8, or if it is a stand-alone dedicated-use building in accordance with CFC 1207.7.1. Provide analysis to determine further requirements.

2.1.4 Where the maximum allowable quantities (MAQ's) per CFC Table 1207.5 are exceeded, a Failure Modes and Effects Analysis (FMEA) or other approved Hazard Mitigation Analysis shall be included in the project submittal or justify why MAQ limitations are not applicable.

2.1.5 Provide copies of testing documentation from an approved, nationally recognized testing laboratory (NRTL). Acceptable NRTL's may be found on the OSHA website at: https://www.osha.gov/nationally-recognized-testing-laboratory-program/current-list-of-nrtls

2.1.6 Show compliance with Underwriters Laboratories (UL) Standard 9540, applicable to all battery systems, except lead-acid batteries, UL 9540A for large-scale fire test, CFC 1207.1.5, UL 1741 for utility interactive systems, CFC 1207.3.3, and UL 1973 applicable to all battery types except lead-acid.

2.1.7 Provide information on the capacity of the array and the rack separation, CFC 1207.5.1.

2.1.8 If UL 9540A is used to demonstrate large-scale fire testing compliance, the testing shall include a cell level test, module level test, and unit level test. The test report shall be submitted with the project. The report shall be prepared by a Fire Protection Engineer holding a valid Professional Engineer license in at least one state in the United States, CFC 1207.1.5 and CFC 104.8.2.

2.1.9 Use of CFC 1207.8.3 Exception 3 requires a large-scale fire test report in compliance with UL 9540A that includes, cell level test, module level test, destructive unit level test and an installation level test. The report shall be prepared by a nationally recognized testing laboratory (NRTL) and reviewed by a Fire Protection Engineer holding a valid Professional Engineer license in at least one state in the United States.

2.1.10 Provide current copies of manufacturer's specifications, ratings, and listings for each BESS, CFC 1207.1.3.

2.1.11 Provide information on the Battery Energy Storage Management System – Required when indicated as part of the BESS manufacturers listing, or state not required, CFC 1207.3.4.

2.1.12 Provide information on the commissioning and decommissioning plan(s), CFC 1207.1.3, 1207.2.1 and 1207.2.3.

2.2 Location on Site

2.2.1 Provide a site plan indicating the separation dimension from the proposed BESS location to lot lines, public ways, buildings, stored combustible materials, high-piled stock, or other exposure hazards per CFC 1207.1.3, and CFC 1207.8.

2.2.2 Provide dimensions on plan to demonstrate means of egress separation, CFC 1207.5.8.

2.2.3 Indicate location(s) of fire department emergency vehicle access roadway on the site plan per CFC 503, and available fire hydrants, CFC 507.

2.2.4 Demonstrate compliance with vegetation control requirements, CFC 1207.5.7.

2.2.5 Where subject to impact by vehicles, provide impact protection, CFC 1207.4.5.

2.2.6 Provide an approved water supply capable of providing a minimum of 1500 gallons per minute at 20 psi residual pressure for fire-fighting purposes. Reflect location(s) of fire hydrant(s) on plan, CFC 507.

2.2.7 Indicate the manner of safeguarding BESS against unauthorized entry, CFC 1207.4.9.

2.3 Enclosure

2.3.1 Specify the size of the enclosure on plans and demonstrate compliance with CFC 1207.5.6.

2.3.2 Specify noncombustible construction, CFC 1207.3.5.

2.3.3 Provide details of hourly fire-resistance ratings of assemblies enclosing the BESS, CFC 1207.1.3; (If considered a dedicated-use building, CFC 1207.7.4.)

2.3.4 Provide information on smoke or fire detection system, CFC 1207.5.4, 907.2. Show alarm signals to be transmitted to a central station, proprietary station, or remote station, or an approved constantly attended location. CFC requires a fire detection system where the installation is in rooms, indoor areas, and walk-in units. The owner must acknowledge to DSA in writing if they choose to omit the fire detection on an outdoor installation where the enclosure is not a walk-in unit.

2.3.5 Provide information on the type of fire suppression system, CFC 1207.5.5, Table 1207.7.7 and Table 1207.8, applicable to the installations where the enclosure is room and area within building and walk-in unit.

2.3.6 Provide information on technology-specific protection requirements as applicable, CFC 1207.6 (exhaust ventilation, thermal runaway management, explosion control).

2.3.7 Provide information on the egress door hardware and direction of swing, CEC 110.26, 110.34 and 706.

2.3.8 Provide information on means of illumination, CEC 110.26, 110.34 and 706.

2.4 Signage

2.4.1 Show the location(s) on plan for the required signage, CFC 1207.4.8 and CEC 706.

2.4.2 Show notifications and markings for disconnecting means, CFC 1207.4.1 and CEC 110.21(B) and 706.15 (C).

3. BESS GENERAL REQUIREMENTS

3.1 Pre-Application Meeting

3.1.1 Submit a pre-application meeting request form for the respective office of the region the project is located (DSA 91-Oakland, DSA 92-Sacramento, DSA 93-Los Angeles, DSA 94-San Diego) prior to submitting the project for review.

REFERENCES:

2022 California Code of Regulations (CCR) Title 24
- Part 2: California Building Code (CBC), Chapter 17A
- Part 3: California Electrical Code (CEC), Article 706
- Part 9: California Fire Code (CFC), Section 1207

ASCE 7: Minimum Design Loads and Associated Criteria for Buildings and Other Structures, Chapters 13 and 15
DSA IR 16-10: Cargo Container Conversion to Modular School Buildings